BIOSYSTEMATIC STUDIES IN HAWAIIAN TETRAMOLOPIUM (COMPOSITAE: ASTERACEAE)

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Recent field and experimental studies of Hawaiian plants have contributed a wealth of information concerning evolutionary histories and diversity of insular species in the tropical Pacific. These investigations are especially important in view of past and continuing devastation of the native Hawaiian flora. Biosystematic studies of the genus Tetramolopium in Hawai'i are being conducted to elucidate the evolutionary trends and relationships of the species and to provide further insight into the evolution of insular taxa in general.

Tetramolopium is a genus in the family Compositae comprised of low shrubs occurring in the Hawaiian Islands and New Guinea. Approximately 21 species are recognized in New Guinea (Koster 1966) and 13 poorly known species and 11 varieties are described for Hawai'i. The genus is considered to be the descendant of late Tertiary immigrants into New Guinea from Australasia (Smith 1977). Smith (1977) suggested that Tetramolopium arose as a Neoendemic in the early Pleistocene and was subsequently dispersed to the Hawaiian Islands, probably in recent times. Speciation in Hawai'i is considered to have resulted from only one introduction (Fosberg 1948).

Tetramolopium has undergone moderate adaptive radiation in Hawai'i. In contrast to the rather mesic high montane habitats occupied by the New Guinean species, the Hawaiian taxa generally occupy specialized submesic to xeric habitats ranging in elevation from sea level to 3300 m (10,800 ft). The Hawaiian species are very distinctive from each other in their morphology and ecological preferences. For example, T. rockii is endemic to a narrow band of lithified calcareous sand dunes on West Moloka'i. Tetramolopium humile grows in pioneer habitats in alpine-subalpine regions of the high volcanoes on Maui and Hawai'i. Also, recently rediscovered, T. consanguineum var. leptophyllum is one of the last extant dry forest species of the genus and is restricted to the central plateau of Hawai'i. Five of the 13 species are presumed extinct. They are T. arbusculum, T. arenarium, T. capillare, and T. tenerrimum. These extinctions are largely attributable to destruction of the habitats through overgrazing. Furthermore, all but one species are considered to be rare and endangered. In view of their rarity it is noteworthy that all extant species have been raised to fruiting in the greenhouse.

The island distribution of the Tetramolopium taxa is given in Table 1. One species previously had been recorded as occuring on Kaua'i and, therefore, constituted a major disjunction from Hawai'i. It was based on one collection by the U. S. Exploring Expedition in 1840. However, there is evidence suggesting the locality information was wrong and the specimen probably came from the island of Hawai'i.

FIELD RESEARCH

Extensive field work has revealed an undescribed taxon, unrecognized relationships between taxa, and the locations of several populations of species previously considered extinct. The undescribed taxon grows on sea cliffs of northern Moloka'i and one area of West Maui. Its closest relatives appear to be T. rockii and T. remyi. The taxon is distinctive in habitat preference, habit, and pubescence.

Field observation of the species pairs, T. filiforme-T. polyphyllum and T. rockii-T. calcisabulorum, strongly suggests that each pair constitutes only one species composed of two infraspecific taxa. The taxa within the pairs are morphologically similar and have sympatric distributions. Growth studies under uniform conditions support this proposal but does confirm the presence of a definable level of distinctness warranting the continued recognition of four taxa.

CYTOLOGY AND ARTIFICIAL HYBRIDIZATION

The cytology of the Hawaiian taxa as determined for eight species from 18 populations is uniform. The chromosome number is n=9 with no observable meiotic abnormalities. A previous count of n=7 that is established in the literature for T. humile var. humile has not been substantiated.

Natural hybridization is recognized as being a widespread phenomenon in the Hawaiian flora. The Compositae in Hawai'i provide some of the best known examples as evidenced in the Silversword complex (Carr 1978) and Bidens (Gillett & Lim 1970). It is interesting then that Tetramolopium shows no incidence of natural hybridization which perhaps is due to the allopatric distribution of the species.

In order to assess species relationships and the potential for hybridization, research is in progress to produce artificial interspecific F_1 hybrids. Thus far all attempts have been successful. The hybrids are vigorous and morphologically intermediate between the parents. Pollen stainability (Table 2) in all crosses except those involving T. humile is 98% or greater. Normal bivalent pairing is observed in all hybrid combinations.

CONCLUSION

The cytological and experimental hybridization studies indicate a close relationship between all *Tetramolopium* species in Hawai'i despite their great morphological diversity and distinctness. Chromosome repatterning probably has not played a major role in the evolution of the genus. The species form a natural group in which allopatric speciation from a single introduction has proceeded.

LITERATURE CITED

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TABLE 1. Distribution of *Tetramolopium* in Hawai'i (where * = taxa endemic to one island).

O'AHU	MOLOKA'I	LĀNA'I
*T. filiforme Sherff	*T. calcisabulorum St. John	T. conyzoides (Gray) Hbd. var. conyzoides
T. lepidotum (Less.) Sherff var. lepidotum	T. conyzoides (Gray) Hbd. var. conyzoides	*var. dentatum (Mann) Sherff
var. luxurians (Hbd.) Sherff	*T. rockii Sherff	T. lepidotum (Less.) Sherff var. lepidotum
*T. polyphyllum Sherff	T. sp. nov., ined.	var. luxurians (Hbd.) Sherff
*T. tenerrimum (Less.) Nees		T. remyi (Gray) Hbd.

MAUI	HAWAI'I
*T. arbusculum (Gray) Sherff	T. arenarium (Gray) Hbd. var. arenarium
T. arenarium (Gray) Hbd. var. arenarium	*var. confertum Sherff
*var. dentatum Hbd.	T. consanguineum (Gray) Hbd.
*T. capillare (Gaud.) St. John	*var. consanguineum [formerly thought to occur on Kaua'i]
T. conyzoides (Gray) Hbd. var. conyzoides	var. leptophyllum Sherff
T. humile (Gray) Hbd.	T. conyzoides (Gray) Hbd. var. conyzoides
*var. humile	T. humile (Gray) Hbd. var. humile
T. remyi (Gray) Hbd.	*var. skottsbergii Sherff
T. sp. nov., ined.	*var. sublaeve Sherff

TABLE 2. Pollen stainability in parents and F_1 hybrids.

Taxon	# of Hybrid Individuals Examined	Pollen Stainability (%)
Tetramolopium humile	-	96
T. humile var. *skottsbergii*	-	97
T. lepidotum	-	97
T. remyi	-	95
T. sp. nov., ined.	-	96
T. lepidotum X *T. remyi*	6	99
T. lepidotum X *T.* sp. nov., ined.	3	98
T. lepidotum X *T. humile* var. *skottsbergii*	7	79
T. remyi X *T.* sp. nov., ined.	5	99
T. remyi X *T. lepidotum*	6	98
T. remyi X *T. humile* var. *skottsbergii*	5	87
T. remyi X *T. humile*	5	86